Potential Effects of Projected Sea Level Rise on Coastal Archaeology at Tolowa Dunes State Park, Del Norte County, California

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Abstract:

Climate change and sea level rise is being addressed by a variety of government agencies and interest groups. All are trying to find a planning process they feel works best for their holdings. California Department of Parks and Recreation (State Parks) is no exception, and has begun drafting documents in an interdisciplinary effort to address sea level rise and storm surge scenarios for their coastal jurisdiction. State Parks manages roughly 300 miles of the California coastline, which includes hundreds of archaeological sites. Tolowa Dunes State Park, in Del Norte County, is ranked 'Highly Vulnerable' (DPR 2011) and has already begun to erode into the Pacific Ocean, exposing cultural deposits to damage from possible looting, animal activity, or wave crash. By using a series of geographic information system calculations, I was able to map the next century of inundation. Tolowa Dunes State Park has numerous prehistoric and protohistoric fishing camps, endangered species habitats, and multiple sites listed on and eligible for listing on the National Register of Historic Places, including the site of the Tolowa people's Genesis. This paper will discuss these significant areas and their risk of inundation due to climate change induced sea level rise in the near future.

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CHAPTER 1: INTRODUCTION

Earth has never hosted a stagnant climate, neither ~~-~~seasonally nor over millennia. Many of the changes in land-surface temperature can be explained by a drastic but natural process, such as volcanoes or evidence for human greenhouse gas emissions (Berkeley Earth 2012). Other changes are a slow and natural process, such as the melting of ice sheets. The debate on climate change is currently not centered around, does the atmospheric and surface temperate change, but rather the *rate* at which they are indeed changing. These changes are occurring at an increasing rate not previously experienced, leading to reactions not previously calculated. This investigation was brought forth in a collaborated effort to investigate how climatic changes over the past, and how future changes, could affect Tolowa Dunes State Park (Tolowa Dunes). A grant through the North Pacific Landscape Conservation Cooperative (NPLCC) allowed for the California Department of Parks and Recreation (State Parks) to not only model how climate change, specifically sea level rise, will effect Tolowa Dunes, but to also obtain information on past catastrophic events and incorporate traditional ecological knowledge (TEK). A three-part grant to this caliper will provide State Parks a holistic interpretation of Tolowa Dunes. The following contribution utilizes the most recent data to create Geographic Information Systems (GIS) models of coastal inundation as an interpretation of potential effects. Sea level rise was the focal point in the climate change investigation because of its ability to cause such drastic erosional damage, a damage which can be rerecorded every visit. Throughout this investigation, *damage* is deemed as anything that removes, alters, or destroys archaeological deposits.

After a brief introduction, which covers the roles of State Parks and Tolowa in the region, this report will take a deeper look at what the leading climate change scientists have to say and how these patterns might be impacting Tolowa Dunes. Geographic calculations mapped expected inundation rates and areas of high risk of erosion. This information was then utilized in my survey methods. Included in these results are survey coverage maps followed with my summary and conclusions, which will briefly discuss the theoretical and political issues with climate change effects at Tolowa Dunes.

CALIFORNIA DEPARTMENT OF PARKS AND RECREATION

State Parks manages a diverse 300 miles of the California coastline, and Tolowa Dunes borders the Pacific Ocean by eight miles seasonally (DPR 2011). Roughly 786 miles (1,265km) of California's coastline (72%) coastline is characterized by steep, actively eroding sea cliffs, including 646 miles (1,040 km) of relatively low-relief cliffs and bluffs, typically eroded into uplifted marine terraces (Dalrymple et. al.2012). The remaining 28% of the coastline is relatively flat, comprised of wide beaches, sand dunes, bays, estuaries, lagoons, and wetlands (Dalrymple et. al. 2012: 17). Tolowa Dunes is an example of this 28%, which is why it was specifically targeted for climate change research. Its environment is unique, with dune forests, seasonal ponds, and the Smith River flowing at the North end.

The park was classified as Tolowa Dunes State Park by the California Parks and Recreation Commission in 2001, but was originally called The Lakes Earl and Talawa Project when it was first acquired (Hood 1981). Before it was a park, the area was forcibly removed from the Tolowa as violence and ranchers pushed them further and further from their original village site. At least four large dairy ranchers occupied the area before the State of California(Hood 1981: 3). Dairy ranching in Del Norte became very lucrative in the 1880s, and Tolowa Dunes is still boarded on the east by cattle ranchers (Hood 1981).

Figure 1: Looking West from Pala Rd to Ranch at CA-NDO-19/H in late 1970s. Buildings stand where cemeteries are today.

CLIMATE CHANGE

Information on sea level rise is rapidly changing, but for the purpose of this investigation I utilized the 2009 Pacific Institute's geographic information as a base for sea level rise in Del Norte County (Heberger et. al 2009). I examine where erosion, presumably from winds and sea-level rise, has or will expose archaeology to damage. Pacific Institute utilized the leading data on climate change, which currently comes from the Intergovernmental Panel on Climate Change (IPCC).

According to their website, the IPCC is "a scientific body under the auspices of the United Nations. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters" (IPCC: Organization). In 1988 the United Nations' Environment Programme and World Meteorological Organization formed IPCC specifically for climate change and it is now the reference material for the world's climate change discourse. They do not pay scientists for their research and only put out large reports every 5-6 years, with the next report began in late 2013. The information is compiled from hundreds of scientists from around the world. Recently there has been scrutiny on the process of IPCC with a call for more frequent and targeted research, rather than one report every 5 - 6 years, due to the frequent leaps in scientific information (Goldenberg Sept 4, 2013). For the purpose of this report, IPCC information from the 2007 report was used, with some information supplemented by what few 5th Assessment Report documents have been approved, including a Summary for Policy Makers.

LOCATION AND ENVIRONMENT

It is predicted that Tolowa Dunes is at risk of erosion due to it being mainly a sandy shoreline with the exception of Point St. George, which has exposed bedrock cliffs. Similar sandy shoreline structures worldwide have seen a less than 10% prograding. There are many contributing factors to erosion, but when the combined heights of a tide, surge, wave set up, and wave runoff during extreme storms exceed the base of the dunes, the area is vulnerable to erosion and landward lying assets are at risk (Palmsten et. al 2011).

This area was once marked by mixed evergreen forests, montane forest, grand fir-Sitka spruce, lagoons and estuaries (Hildebrants 2007: 84). The Park now hosts an incredibly preserved and unique dune forest system that is one of three of its kind in California; the other two being Lanphere Dunes in Humboldt County and Jughandle Reserve in Mendocino County

(Roberts 2010). Additionally, the barrier dune system at Tolowa Dunes results in high groundwater elevations that support a larger region of aquatic features. The abundant hydrologic resources allow for the effects of storm surge and sea level rise to have a dramatic navigation effect by pushing and eroding the mouth of the Smith River and potentially flooding seasonal ponds. The wetland ponds could be considered an "Environmentally Sensitive Habitat Areas" pursuant to Section 30107.5 of the California Coastal Act which would then require protection from all adverse activities (Roberts 2010). The National Parks Service and State Parks both hold policies that allow natural processes (erosion, species migration, etc.) and change to dominate thelandscape (DPR 2011). This becomes difficult to interpret when discussing whether or not climate change is a man-made or natural process. Section 0304.2.5 of the D.P.R. Operations Manual states that "Natural Preserves [PRC § 5019.71] are distinct areas of outstanding natural or scientific significance established within the boundaries of other State Park System units." (Roberts 2010). It continues to say that "The purpose of Natural Preserves shall be to preserve such features as rare or endangered plant and animal species and their supporting ecosystems," (Roberts 2010). The dunes forest and associated ponds should thusly be considered environmentally significant features, "Natural Preserve" areas. Between these policies, State Parks is both supposed to allow natural activity to occur, while still actively preserving a stable, somewhat stagnant, setting.

Unfortunately, Tolowa Dunes does not have a General Plan. A park's General Plan provides guidance for future management and/or development; a park must have a General Plan before any major facilities may be constructed. ("General Plans and Classification Actions"; Douglas 2010). Additionally, in order for a park to gain a subclass, such as Nature Preserve, Cultural Preserve or State Wildlife Preserve, it needs to first have General Plan. As well as a

Nature Preserve discussed above, Tolowa Dunes could potentially be considered a Cultural Preserve. According to the California State Parks Planning Handbook, page 111, a Cultural Preserve consists “of distinct non-marine areas of outstanding cultural interests established within the boundaries of other state park system units for the purpose of protecting such features… Areas set aside as cultural preserves shall be large enough to provide for the effective protection of the prime cultural resource from potentially damaging influences” (California State Parks Planning Division 2010). Theoretically, once Tolowa Dunes gained a General Plan, it would immediately call for the additional sub-classifications of Natural and Cultural Preserve due to the unique dune system and two National Register sites.

TAA-LAA-WA DEE-NI’ (Tolowa People)

The Tolowa Dee-ni’ of The Smith River Rancheria have, since their genesis, lived in the area of Yontocket. According to the Smith River Rancheria web site, the “*Taa-laa-waa- dvn* (Tolowa-Ancestral-Land) lays along the Pacific Coast between the water sheds of Wilson Creek and Smith River in California and the Winchuck, Chetco, Pistol, Rogue, Elk and Sixes Rivers, extending inland up the Rogue River throughout the Applegate Valley in Oregon (Figure dvn ranges over what are today Curry, Josephine and Del Norte Counties” (Bommelyn Mar. 2011). The Taa-laa-wa Center of the World is located at what is now recorded as CA-DNO-19/H and is in the lower regions of their territory.

Over the decades of research in the Tolowa territory, *Yontocket* has been spelled and pronounced a number of ways. From the phonetic *Yontockett* or *Yotokut*, to *Yan'-daa-k'vt*, *Yon'-dó-kut*, and its record name: CA-DNO-19/H, and I am sure many more ways not found in recent academic works. According to some of the earliest research conducted by Waterman on village place names, Yontucket ranch (Yδ^{n}-t'akit) meant "high in the east" (Waterman 1925: 531). For the rest of his report, the Anglicized version, Yontocket, will be used when referring to CA-DNO-19/H and surrounding area. Tolowa Dee-ni' however, derives from a combination of what Tolowa refer to themselves as, *Dee-ni'*, and the name placed upon the Athabascan group, *Tolowa*, by their Yurok neighbors (Kroeber 1976). *Tolowa* was "nothing more than a term denoting a certain speech and implying perhaps certain customs" (Kroeber 1976:125).

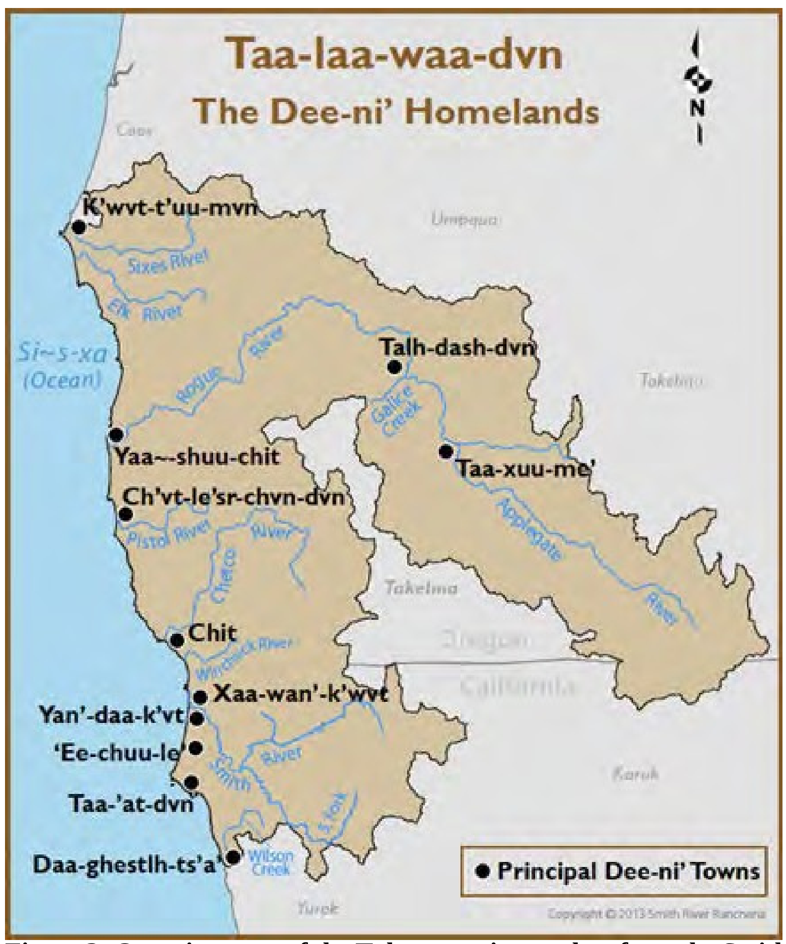


Figure 3: Overview map of the Tolowa territory taken from the Smith River Rancheria website (www.tolowa-nsn.gov/tolowaculture/our-

GENESIS AND GENOCIDE

The Tolowa Genesis began with the existence of Thunder, Baby Sender, and Daylight, all who lived in a Sweat House at Yontocket. In short, Baby sender chased out the cold and with the help of Daylight, created a First Place (Bommelyn 1985). After the ocean, the fish, the sky, and the birds were came to be, the first woman was made and “Baby Sender told Daylight, ‘this woman will be your wife. You will have many children. You will be the father of all those to come.’” (Bommelyn 1985). It is here that the first Redwood grew. As a celebration of the creation, Tolowa, Yurok, and Chetco people gather at Yontocket for the ten day Naydosh ceremony, also referred to as the World Renewal Ceremony. This celebration included hours of all night dancing, singing, and scriptures that illustrate the Creation story (Bommelyn 1985).

Pre-contact population numbers vary from 450-2,400 with the village at Yontocket expected to be at about 300 (Gould 1978; Bommelyn 1985). There was possible colonial contact during the late 1700s, at Point St. George (CA-DNO-11), where it is suspected western disease diminished the village population there (Gould 1978). The first largely influential explorer however, was Jedediah Smith when he passed through along the Smith River in 1828 (Bommelyn n.d.). A short time later the Gold Rush in 1849 and the addition of California to the Nation in September 1850, led to the dehumanization and subsequent holocaust of Native California People and lasted for decades. At the height of the 1853 winter solstice Naydosh Celebration, when many gathered at Yontocket, the village was surrounded by men from Crescent City and at dawn, raided (Van Kirk 1998). The Del Norte Record reports that in early 1853, “California Jack” went to prospect the Smith River. Once he did not return, but his engraved gun was found on an Indian man, a crew from Crescent City went to the village at Battery Point seeking revenge. They killed 9 that day, but did not feel it was sufficient. A formation of thirty three men sought revenge by surrounding Yontocket Ranch, and at dawn a brutal raid took place. The paper reports that women and children were saved, but Native accounts differ greatly. A large fire was fed by the invaders, engulfing the village and thus the term Burnt Ranch replaced Yontocket Ranch. The Del Norte Report continues by saying that “it was afterwards reported that this particular band of Indians were perfectly innocent of having anything to do with the murder on the Smith River [California Jack], and that the slaughter at the Yontucket Ranch was uncalled for" (Van Kirk 1998). The lowest estimate is that 450 died that day, with only a handful surviving by jumping into the Yontocket slough (Bommelyn 1985: 4). One survivor, Pyuwa, slipped into the slough and used water lilies to breath, as militia waited for survivors to emerge from the red slough It was only the first of three large massacres the Tolowa would experience in the upcoming years (Norton 1979; Gould 1966; Thorton 1984).

In 1864 the few Tolowa survivors lived in new houses on the ruins. A man from the Chetco River, KWUTL-NAY-SHAW, and a woman from Yontocket, LAH-SAY-GHEE-NAH, married and many of the Tolowa decedents come from their five children: Lizzie Grimes Bigby, Betsy Grimes Brown, John Grimes, Eunice Grimes Pecwan, and Polly Grimes Stewart. The last Tolowa to live in the Yontocket area, Rawleigh Grimes, dies in 1953 and C. M. Johnson bunt the entire area to rid any indication of the village (Bommelyn 1985).

The Tolowa share similarities with their neighbors but were unlike the Plains Indians that many Americans had come to know, and social and political structures were placed upon the Tolowa by neighboring authorities. The *tribe* concept was awkward as it was paired with paternal gentile style of the Tolowa people. In actuality, the "concept of village and tribe was essentially nonexistent, as the individual or immediate family took precedence"; one was *Tolowa* only when noted by others (Hildebrandt 2007: 84). These similarities cross over into language. The Northwest region was a linguistically diverse landscape and once included 20 distinct languages representing five linguistic families (Hildebrandt 2007: 84). The Athabascan family was one of the largest and included Tolowa; Hupa; Mattole; Southern or Kinnestet, Kuneste, Wailaki; and the Rouge River (Kroeber 1976). Other Athabascan groups settle along the lower hills of a region, however some within the Athabascan Northwest Coast Culture lived in higher densities along permanent coastal locations (Hildebrant 2007, Kroeber 1976). The general 'hill people' trend that Kroeber notes does allow for stream drainages to be an absolute line, and we see this with the Tolowa focal village at the mouth of the Smith River. The Tolowa were able to live here on the help of ample food storage and general pursuer hunting style. Annual runs of salmon, seasonal sea lion and fur seal visits on the offshore rookeries and fall gathering of acorns, berries from further in, allowed for targeted food sources in dense areas, versus gaining a wide range of prey over a dispersed area (Fredrickson 1984). Although shorelines were village-specific, river banks and deer hunting grounds could be owned for personal use, or rented out (Waterman 1972: 255).

TOLOWA DUNES ARCHAEOLOGY

Research in the region of Tolowa Dunes has been active since at least the 1880s with larger investigations beginning in the 1900s (Waterman 1925; DuBois 1932; Moratto 1984; Parkman 2006). The Historic District nomination was a milestone in recognizing the Tolowa landscape, but research continues and the NPLCC adds a new approach to understanding not only the past, but the region's future. A valuable addition to understanding history within Tolowa ancestral lands comes from the ethnographic research. Interviews with elders like Bertha Grimes Stewart, Amelia Brown, Sam Lopez, and Eddie Richards offer personal insight and family stories not found in any archaeological record (Parkman 2006; Gould 1966b; Interview with Amelia Brown). The NPLCC will expand on the ethnographic perspective with the TEK component.

Previous to this report, there were 23 recorded sites within the Tolowa Dunes State Park legal boundary, briefly described in Table 1 below. Table 1 takes into account numerous updates, original documents, ethnographic research, or State Park projects in the area.

Figure 4: Gould excavations at CA-DNO-11 in 1966. Photo on record at State Parks, NCRD, Cultural Resources Department. Eureka, CA.

Table 1: Updated Archaeological Inventory of Tolowa Dunes State Park

Site Name	Other Names Associated with Site	Recorded by:	Recording Office:	ost Recent Report:	Brief Resource Attributes
Smith River Bank Buried Site			FarWestern	2011	Hearth/ pits along river bank
CA-DNO-XX10		Tushingham, Shannon	UC Davis Anthropology	2004	Fire Cracked Rock
CA-DNO-XX11		Tushingham, Shannon	UC Davis Anthropology	2004	Lithic scatter
CA-DNO-XX8		Tushingham, Shannon	UC Davis Anthropology	2004	Lithic scatter
CA-DNO-XX9		Tushingham, Shannon	UC Davis Anthropology	2004	lithic scatter; habitation debris; groundstone
CRF-YON-01/H		Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Lithis and shell scatter; Trash scatter; walls/fences
CRF-YON-02H		Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Historic debris scatter
CRF-YON-03/H		Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Lithic and shell scatter; lumber scatter
Point St. George Site	Taa-ghii~'a~	A. Whitaker	FarWestern	2010	catter; architectural feature; burials; hearth/pits; habitation debris
CA-DNO-19/H	Yontocket	Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Lithis scatter; habitation debris; house pits; burials; graves/cemetery; trash scatter; roads; orachard; foundation; lumber
CA-DNO-22		Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Lithis and shell scatter.
CA-DNO-52	Sastaso; DNO-11b	A. Whitaker		2010	Burial; habitation debris
CA-DNO-53		J.Burns, M. Salisbury,	hSU-CICD-CRF	2008	Lithic Scatter; Shell Scatter
CA-DNO-247		Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Lithic Scatter; Shell Scatter
Ca-DNO-248		Roscoe, Tayloe, Angeloff, Patton, Van Kirk, Taggert		1998	scatter, ground stone and chertflakes
Ca-DNO-250H	Cadra House (LET-H-1)	McGuire, Pam		1981	circa 1870s domestic dwelling, now vacant
CA-DNO-254H	McLaughlin Barn, #2	McGuire, Pam		1981	or cattle barn, possible hay storage
CA-DNO-299H	LET-1-89	Hood, Beverly; Hood, Joe	State Parks and Recreation	1989	Historic Trash Deposit
CA-DNO-335	P-12-000353; Sweetwater	Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Lithic and Shell scatter, banitation debris
CA-DNO-1030	NO-XX4; P- 000350	Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Lithic and Shell Scater
CA-DNO-1031	NO-XX5; P- 000351	Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Lithic and shell scatter
CA-DNO-1032	NO-XX6; P- 000352	Burns, E. Collins, M. Salisbury, M. Steele	HSU-CICD-CRF	2008	Lithic and shell scatter

Archaeological indicators are noted from surface survey and excavation. For the purpose of this report, North Coast archaeology spans three generalized time periods: Borax Lake Pattern (8000-3500 BP), Glade Pattern (8000-?BP), Mendocino Pattern (3500-1500 BP), and the Late Period (after 1500 BP) (Tushingham 2006). Previous research has indicated many more time periods broken down from the larger epoch categories into region specific lines (Hildebrandt 2007; Fredrickson 1984).

Historic District

On December 18, 1973 the 21,000 acres of Yontocket Historic District was put on the

National Register (#73000400) and in 1976 Point St. George Site was added, 4,500 acres (#76000481) (California- Del Norte Co. n.d.). The Districts include the village of Yontocket and the associated cemetery (CA-DNO-19/H), Point St. George (CA-DNO-11), CA-DNO-12, CA-DNO-13, CA-DNO-53. The nomination form notes the unique northwestern traits under the Builder/Architect section:

"Relative to other Californian culture areas, the northwest area is marked by numerous idiosyncratic traits. Among these are split wooden-plank houses and sweathouses; wooden dugout canoes; carved wodden pillows, acorn mush paddles, and boes; emphasis upon wealth, with dentalium shell money and certain "treasure" items; twined basketry caps and receptacles; special adzes, mauls, antler chisels and wedges for woodworking; carved elkhorn spoons with fancy handles; tubular tobacco pipe with wooden shaft and stone bowl; and carved antler purses for shell money. The north coastal Indians were also known for their minimal political organization and their participation in the World Renewal religious cult." (King 1973)

The Districts are important when considering a General Plan and Climate Change mitigation for Tolowa Dunes. National Register Districts don't require protection from manipulation if no federal funds are utilized for the project. The state can only be concerned with what happens within the park boundary. Complications arise when the legal Universal Transverse Mercator coordinates and the "on-the-ground" alignments differ greatly due to climate change effects such as a meandering river mouth or eroding dune face. All of these factors contribute to what would appear as Tolowa Dunes shrinking.

CHAPTER 2: CLIMATE CHANGE

Climate change, specifically the increasing rate of change, has seen a paradigm shift in its surrounding discourse, settling in recent years on the anthropogenic stimuli. These stimuli, however highly debated their effects may be, have been potentially changing the Earth's climate since the Industrial Revolution, with effects felt on both the local and global scale. It is not enough to say that the climate is changing and that is bad for *everything*. Earth has had fluctuating surface and atmosphere temperature since the scientific beginnings. What is concerning is that the rate at which these temperatures now fluctuate does not fall within the previous patterns; it has kicked up the speed to faster than most can adapt. For example, sea level had been rising for about 20,000 years, initially due to natural processes at the end of the Last Glacial Maximum (Reeder et.al 2012). The last deglaciation caused the annual rise of 10 millimeters on the west coast of the United States (Dalrymple et. al. 2012). This melting rate slowed to almost zero roughly 2,000 years ago, only to rise again starting between 1840 to 1920 (Dalrymple et. al. 2012). Additionally, since 1906 the mean global annual surface air temperature has increased 0.74°± 0.18°C and the Pacific Northwest specifically, has increased in frequency of heat waves since 1950 (Dalrymple et. al. 2012).

The distribution of water on Earth's surface plays a role in temperature and precipitation patterns globally (Furniss, et. al 2010:19). In recent decades, the primary reason for sea level rise is expected to be from intensified greenhouse gasses being trapped in the atmosphere and rising global temperatures. This increased heat led to the thermal expansion of ocean water. Seawater becomes less dense and expands when the ocean becomes warmer (Dalrymple et. al. 2012). The IPCC has set up a range of scenarios for greenhouse effects on sea level rise. Repercussions from even minor sea level rise would include flooding of San Francisco International Airport, bridge and highway flooding, and disruption of water traffic inland. The effects of climate change are interesting because the effects felt in one area are not consistent with another, much like regional climate variability. One region is experiencing extreme wet effects while another is seeing extreme drying from rapid climate change. In the Pacific Northwest, for the driest quarter of the year, there is already significant decrease in annual stream flows. So what is climate change exactly?

Climate change is defined as:

"a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC "Climate Change 2007: Working Group I: The Physical Science Basis" 2007)

This working definition is from the 2007 Fourth Assessment Report (AR4) from the Intergovernmental Panel on Climate Change. These reports serve as the base for which many organizations, including the National Parks Service, The California State Parks, and the National Academies Press, utilize for framing policy and research. The most recent report began in September 2013 and will involve a series of Working Group meetings around the world, ending in October 2014. This produces reports from information gathered over the last 5-6 years. One of the most recent approved summaries, from the Twelfth Session of Working Group One -of three - is the 'Working Group 1 Contribution to the IPCC Fifth Assessment Report *Climate Change 2013: The Physical Science Basis* Summary for Policymakers'. This summary highlights the advances in climate change research since AR4. This summary of bullet-pointed updated facts provides organizations with information which can then be helpful for forming policy or talking to the general public.

A different approach, a more public-friendly approach, on 'What is Climate Change?' comes from the United Nations Framework Convention on Climate Change, where they refer to climate change as:

"a change of climate that is attributed directly or indirectly to human activity that alters the composition of global atmosphere and that is in addition to natural climate variability observed over comparable times periods" ("Full Text of the Convention, United Nations Framework Convention on Climate Change: Article 1" 2013).

This was specifically defined for the purpose of their meeting, and laid out the verbiage for the following discourse. This can be a communication error. While both define Climate Change, one places blame. While this discussion does not place blame, on natural or human impact, the theories on why climate is changing, will inevitably effect how we deal with it. It would appear that climate change has gained such a negative, and apocalyptic connotation that many feel the discussion surrounding climate change is a bit hysterical. One such individual was Richard Muller. The IPCC has been studying the cause and effects of climate change, and AR4 states that "warming of the climate system in unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." The IPCC has also found that "Most of the observed increases in global average temperatures since the mid-20th century is 'very likely' due to the observed increase in anthropogenic greenhouse gas concentrations." (IPCC 2012) "The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia." (Alexander et. al. 2013). This is seen as a high confidence level that humans are drastically impacting the climate. Richard Muller previously stood out in the scientific community because he voiced skepticism of climate change models, claiming dramatics. Even with the loss of a relatively stable sea level during the industrial era, it is possible that Earth is currently no warmer than during the "Medieval Warm Period" or "Medieval Optimum". Muller has recently changed his opinion to say that climate change is almost entirely caused by humans (Muller, 2012). This claim is more definitive than what the AR4 put out, but is increasingly on par with the Fifth Assessment Report which is being finalized in the upcoming year. In the Approved Summary for Policymakers which came in in September 2013, section

D.3 Detection and Attribution of Climate Change states "This evidence for human influence has grown since AR4. It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century." (Alexander et. al. 2013: 11) It continues to say that "it is *very likely* that anthropogenic influence, particularly greenhouse gases and stratospheric ozone depletion, has led to a detectable observed pattern of tropospheric warming and a corresponding cooling the lower stratosphere since 1961." (Alexander, et. al. 2013: 13). This entire dialog points a finger at human actions and decisions. For exploring the effects on Tolowa Dunes, concentration was on sea level rise and how it erodes away the coast, exposing cultural items to damage. This takes a very large scale event, and attempts to section off problems so that we may learn, understand, and act upon one at a time.

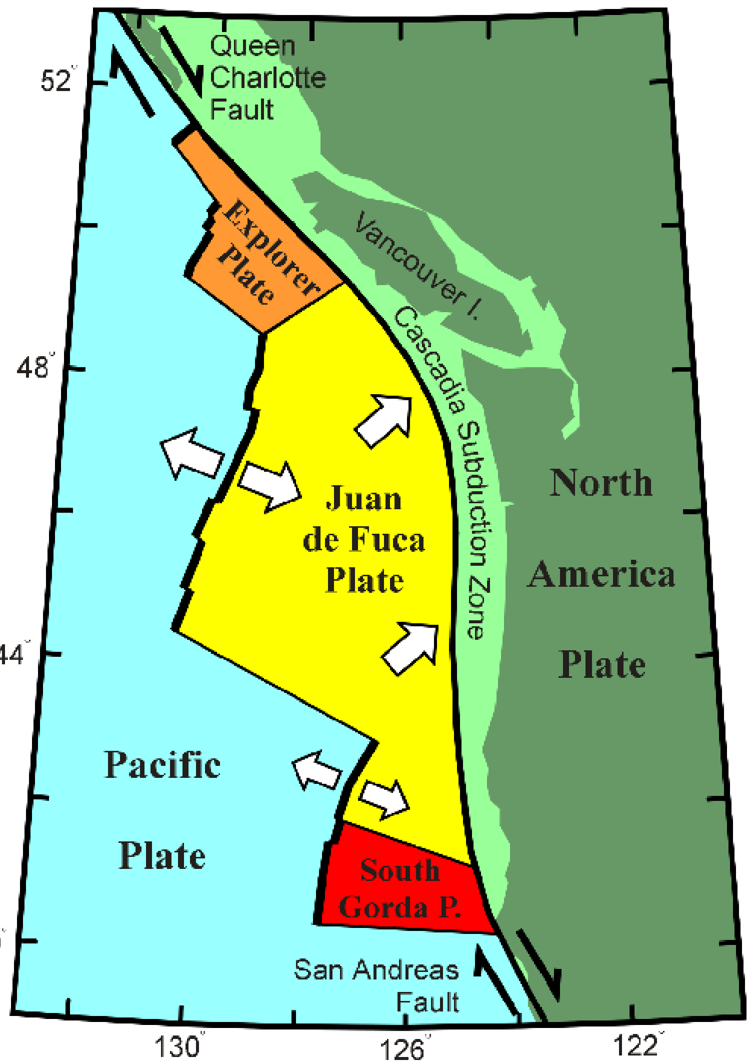


Figure 5: Tectonic Plates of the Northwest Coast (Photo from Britich Columbia Institute of Technology *http://commons.bcit.ca/civil/students/earthquakees/unit1_02.htm*)

Geologic and archaeological (proxy) evidence has been used to calculate rates of global sea-level rise over the past millennia, with increasing input from tribal elders (Carver 1998: 13). Stories of large tsunamis and seasonal variability commonly referred to as Traditional Ecological Knowledge, can aid scientist in focusing their studies. Modern rates include information from the over 2,000 tide gages, which in some places date back to the 17th century, and satellite altimetry measurements of sea-surface heights ,which have been available for the last two decades, (Dalrymple et. al. 2012:23).

Archaeology plays an important role as proxy evidence in getting sub-meter sea level change estimates during the past 2,000 years (Dalrymple et. al. 2012). Examples of proxy evidence can range from more obvious changes such as dietary changes noted in the faunal remains, to micro- atolls and salt-marsh sediments (Dalrymple et. al. 2012). Tide gage accuracy depends on the length of time it has been active and the ability to remove factors such as persistent winds or vertical movement of the tectonic plate it floats above (Dalrymple et. al. 2012). California is tectonically unique because of the subduction zones off the coast and the 3 active plates: North American plate, Pacific plate, and the Juan de Fuca plate. These plates run along the infamous San Andreas Fault line in California and the Cascadia subduction zone off Northwest America (Dalrymple et. al. 2012). The last large earthquake in the region occurred in 1700 and caused a sudden sea level rise of 2 meters because of subsidence, but since that event, California, Oregon, and Washington have been slowly rising (Dalrymple et. al. 2012; Carver 1998). This can actually make it look like the rate of sea level is not as alarming on the North Coast, but when the next large earthquake occurs then the waters will run higher than originally predicted. It’s also important to note that most sea level rise predictive models do not include melting from artic ice sheets (Dalrymple et. al. 2012). California has a distinct line at about Cape Mendocino where south of that is expected to see much higher than projected sea level rise and north will see less than expected due to seismic strain pushing the land upwards

(Dalrymple et. al. 2012). This is not at all to say sea level rise is not of concern. The 'less than global projections' can still be catastrophic to Tolowa Dunes and the Smith River region.

CHAPTER 3: Mapping the Future of Tolowa Dunes State Park

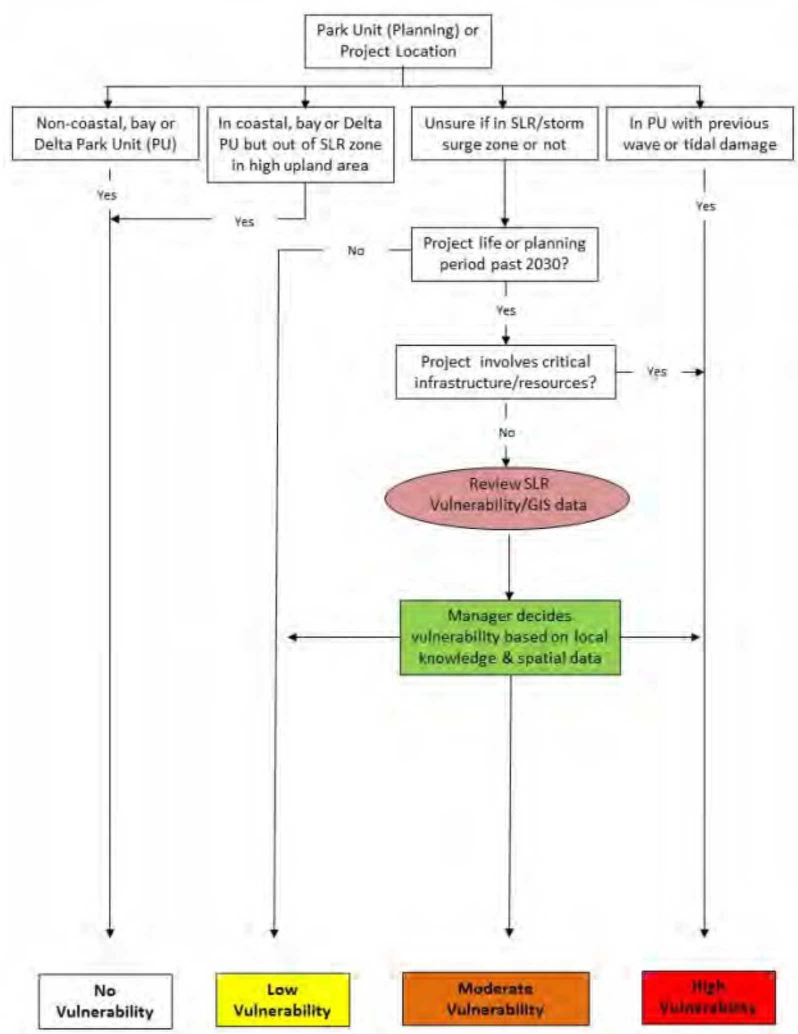
Using mapping software allowed for visual representation of acreage lost at Tolowa Dunes. The purpose here is to take what has been previously proven, if only an estimate, and overlay it onto Tolowa Dunes. California has much to lose in the upcoming years due to climatic changes: not only the inland temperatures and hydrologic concerns, but much of California's population, infrastructure, and income comes from the coastal economy.

CALIFORNIA POLICY

California has many interlocking organizations to address climate change. For example, the Pacific Institute report was put together by Public Interest Energy Research Program of the California Energy Commission and in 2003 the two established a virtual center called California Climate Change Center to document climate change research specifically relevant to California (Heberger et. al. 2009). It can be cumbersome to sort through all the organizations and documents, but they all agree that many people and resources along the California coast will be put at risk if even minor flooding occurs.

Executive Order S-13-08 issued by former Governor Arnold Schwarzenegger November 14, 2008, directed state agencies to consider a range of sea level rise scenario for years 2050 and 2100 (DPR 2010). State Parks created a Sea Level Rise Working Group in October 2011 within their Planning, Policy, and Programming Committee. This Working Group attempted to create a Sea Level Rise and Storm Surge Guidance Document for California State Parks. Unfortunately the California State Parks document only reached draft form (DPR 2010) due to budgetary constraints. The document utilized Pacific Institutes predictive geographic information system (GIS) analysis paired with their own vulnerability chart and risk matrix (Figure 5; Table 2). These two charts were to help Park Management best asses which areas were most at risk. Parks were then ranked in a risk matrix, which put Tolowa Dunes in a High Risk area because it already has erosional damage.

Most recently State of California's Coastal and Ocean working group of the California Climate Action Team updated a document "to inform and assist state agencies as they develop approaches for incorporating, sea level rise, into planning decisions with the most recent and best available science, as published in the 2012 NRC report" (CO-CAT 2013). This is a generalized state document, not specific to State Parks, and admits that "Because of their differing mandates and decision-making processes, state agencies will interpret and use this document in a flexible manner". Current State Parks policy does holds that they will let natural coastal processes to continue without interference and that "the Department shall not construct permanent new structures and coastal facilities in areas subject to ocean wave erosion, sea cliff retreat, and unstable cliffs', and that new structures locate in areas know to be 'subject to ocean wave erosion… shall be expendable or movable.'" (COM 0307.3.2.1) (DPR 2010).



Above: Figure 5, DPR Draft Vulnerability Chart. *Below*: Table 2, DPR Draft Risk Matrix. Both of these put Tolowa Dunes at a high risk for further erosion.

	Low Vulnerability	**Moderate Vulnerability**	**High Vulnerability**
Low Consequences	Low Risk	Low Risk	Moderate Risk
Medium Consequences	Low Risk	Moderate Risk	High Risk
High Consequences	Moderate Risk	High Risk	High Risk

ESRI CALCULATIONS

To calculate expected inundation rates, GIS information was compiled into ESRI's ArcGIS 10.0 mapping software, which the North Coast Redwoods District (NCRD) currently holds a license for. In ArcGIS a basic map was created of Tolowa Dunes with known cultural resource polygons displayed. Over this map, shapefiles[1] were added, overlapped, clipped[2] from each other and queries were run. Files included: public shapefiles from Pacific Institutes latest study; historic atlases, and imagery; geologic predictive models from CalTRANS; ethnographic information; and Del Norte County GIS files (Meyer et al 2011). Each file added to the understanding of the mechanics of the landscape. Public files from Pacific Institute correlated to their most recent report and added significant information as to the possible underlying causes of events. Historic atlas data helped to identify the movement of both the mouth of the Smith River and the movement of the Yontocket Slough, which is actually an old ox bow of the river (Figures 6 and 7). Used in correlation with ethnographic data, movement of the river helped to make clearer the where site might have already been washed away. Erosion has been plaguing the coast for millions of years, which is evident in the off shore rookeries focused at Point St. George and spread into the Pacific to the lighthouse 5 miles off the coast. Archaeologists at CalTRANS have run predictive models, also in ESRI, for buried sensitivity and coastal erosion models from 7000 cal BP and 4000 cal BP (Meyer et al. 2011).

The maps produced for this report which show the predicted coastal inundation at Tolowa Dunes State Park in 2100, are included in a classified appendix which is exempt from the public record per California Government Codes 6254 and 6254.10.

[1] Geospatial vector files used in ESRI and display spatial information
[2] Clip is a tool within ArcGIS which allows me to cut out a piece of one feature class using features in another class, much like a "cookie cutter" effect.

Above: Figure 6, Elbow of the Smith River at Yontocket in 1958, note Yontocket Slough in the bottom Center. *Below*: Figure 7, Elbow of the Smith River at Yontocket in 1980, note Yontocket Slough in the bottom center.

Table 3: Emission Scenarios

YEAR	EMISSION SCENARIO	/ERAGE OF MODELS	RANGE OF MODELS
2030		7in (18cm)	5-8 (13-21cm)
2050		14in (36cm)	10-17in (26-43cm)
2070	LOW	23in (59cm)	17-27in (43-70cm)
	MEDIUM	24in (62cm)	18-29in (46-74cm)
	HIGH	27in (69cm)	20-32in (51-81cm)
2100	LOW	40in (101cm)	31-50in (78-128cm)
	MEDIUM	47in (121cm)	337-60in (95-152cm)
	HIGH	55in (140cm)	43-69in (110-176cm)

Table 3 provides possible emission scenarios compiled by the Science Advisory Team of the California Ocean Protection Council and adopted by state agencies (DRP 2010).

These will of course vary by location, and the 140cm expected high scenario is merely an estimate that has elevated to roughly 2m currently. These scenarios do not include ice sheet melt or harsh seasonal weathers like el Nino, but do correlate to the Pacific Institute shapefiles utilized for Tolowa Dunes.

These predictive model levels are the official levels adopted by the State of California in the CO-CAT report. ArcGIS allowed for me to overlap and clip from each of the various flood levels and expected sea level rise for the region from 2000 to 2100. The 2100 expected sea level rise, with high emissions levels is expected to be 140 cm (55 inches) above the current 100 year flood level (DPR 2011). This rise will put 480,000 people at risk of a 100-year flood event (Heberger et al 2009). I was able, on a 2-dimensional plane, specifically look at sea level rise for each known cultural resources boundary. This proves problematic when looking at potential dune erosion. To combat the ‘cookie-cutter’ effects of working with two-dimensional program, I added a 30 meter buffer zone around each of the sites as a broad estimate of the potential effected area. This estimation does not take into account the physics of dune erosion and effects of infiltration from the numerous aquatic resources. Calculating these effects only becomes more when you consider that the models which have held true over regions or time will not hold to their previous level of accuracy. As the climate changes producing higher storm surge level and general sea level rise, water levels and actions will surely surpass any predictive model.

RESULTS

Two approaches were taken in calculating acreage lost at Tolowa Dunes. First the area lost within Tolowa Dunes State Park's legal boundary only was totaled, then that was expanded that to include area lost within Tolowa Dunes and the area around Tolowa Dunes by 500 meters. Sea levels are not going to rise just within our boundaries and understanding the surrounding effects will be important in any future co-agency mitigation planning. Then using 2000 as a base level, within these two views acreage lost for known cultural resource was calculated for 2100 expected sea levels 2100 predicted coastal erosion model; both developed by Pacific Institute. Though the models predicted that the entire coast will be wiped out by rising tides, the predicted depth was a look at expected regional intensity and was helpful in creating a coastal survey plan.

Table 4: Acreage Lost at Tolowa Dunes

Acreage Lost at Tolowa Dunes State Park: Current and Projected			
Total acres within TDSP:	347	Cultural Resources covered by 2000 flood zone:	215 (62%)
		Cultural Resources covered by 2100 flood zone:	282 (81%)
		Resources covered by 2100 flood and predicted erosion:	195
Total acres of coastal sites:	509	Cultural Resources covered by 2000 flood zone:	277 (54%)
		Cultural Resources covered by 2100 flood zone:	332 (65%)
		Resources covered by 2100 flood and predicted erosion:	211
These calculations are based on 2-D overlay Any area of a site within 500m of TDSP Coastal dunes erosion only			

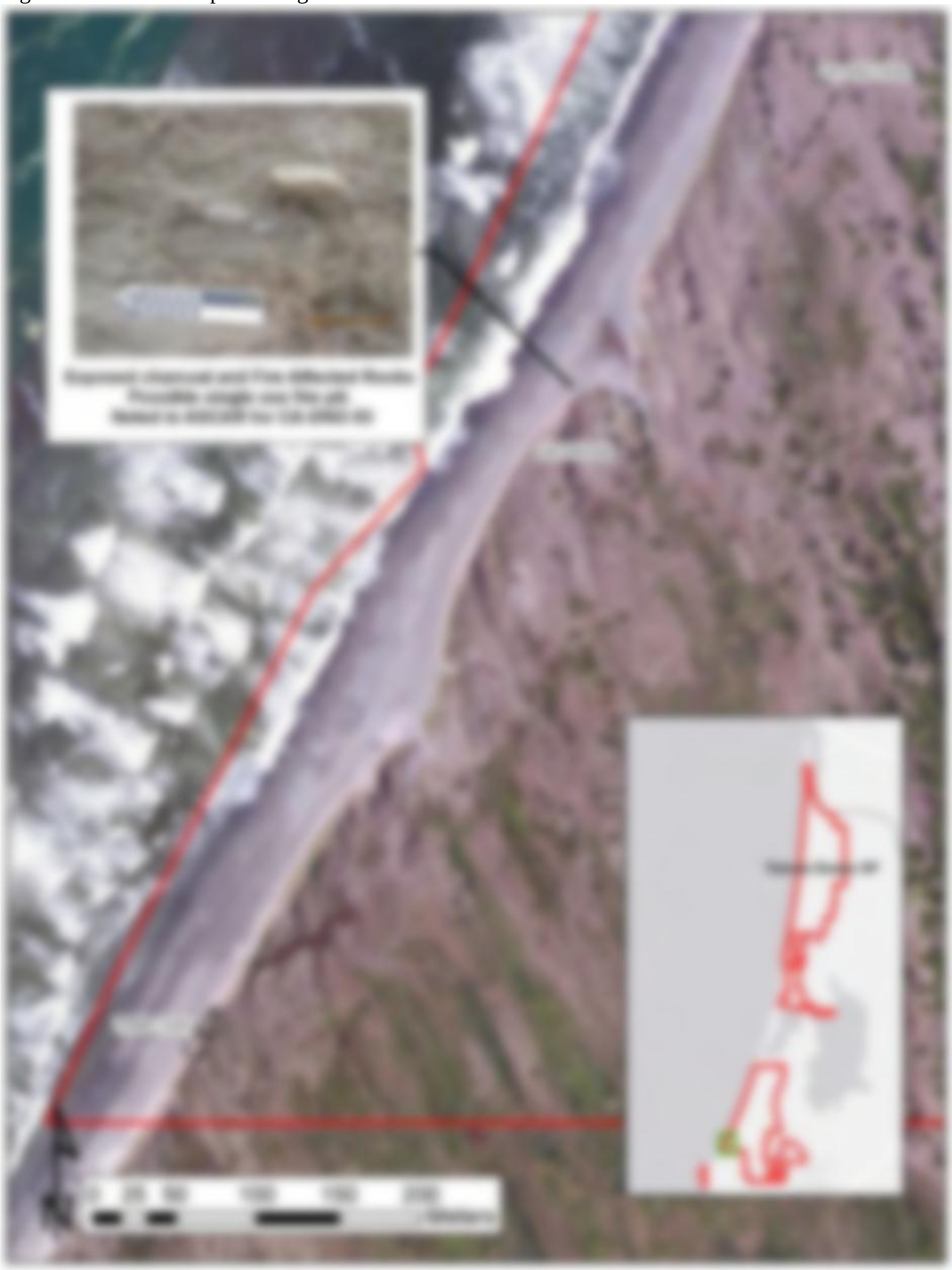
CHAPTER 4: Survey Results

On August 21st, 2013 an intensive pedestrian survey was conducted from the mouth of Sweetwater Creek, CA-DNO-22, south towards Point St. George to where the Tolowa Dunes and Del Norte County Regional Airport boundaries meet. Participants included Erin Chiniewicz and Greg Collins from State Parks and Suntayea Steinruck, Jaytuk Steinruck, Don Steinruck, and Cynthia Ford from Smith River Rancheria. Along this stretch, consistently high dune cliffs with undercuts are seen and expected to be from high tide erosion. These 'cliffs' were topped with beach grass that obstructed our surface visibility. The roots stretch for an average of 2 meters down. As the dune face erodes, material gets swept around tidally, building up small ledges along the foot of the dune.

One dune, near CA-DNO-53, had some minor charcoal fragments and possible fire affected rocks observed eroding from a dune face. Only a handful of charcoal was found and it is unclear if this is the beginning of a site or the last remnants of one. Due to the proximity to the CA-DNO-53 it was added to the site record. Information was added in the form of an Archaeological Site Condition Assessment Record Form (ASCAR), which shows that the site has been updated and assessed for 2013. At the most southern end of the park boundary, a long lens of midden was exposed, roughly 28 meters long, 10-15 centimeters thick, and 2 meters below the top of the dune. Here shell midden, possible ground stone fragments, charcoal, fire affected rock, chitons, clam, and a large mussel shell were recorded. Additionally two historic artifacts were found: a historic metal fragment and a solarized glass bottle neck and lip. (Figures 9, 10). Now recorded as TDSP-13-01, the site is far from any known surrounding sites, including those within the airport boundary, leading us to believe it is a previously unrecorded site.

The entire coastal side of the park is marked by small loci or small, closely situated recorded prehistoric archaeological sites. The most northern section is almost entirely encompassed by CRF-YON-03/H and includes eighteen loci. There is a brief span of no recorded sites and then CA-DNO-248 spans upwards from Lake Earl for 3.4 kilometers (apx. 2miles). The last 3.7 kilometers (apx. 2.3 miles) of park property before Point St. George is marked by two very long coastal sites (CA-DNO-22, 335) and a scatter of 5 smaller coastal sites (CA-DNO-1030, 1031, 1032, 53, and now TDSP-13-01). CRF-YON-03/H was recorded with many loci, as opposed to many sites; but the tailing sites in the south were recorded separately. This can distort how spatial relationships are viewed, but understanding the ethnographic background adds depth to the research. These noted sites are thought to be areas of temporary smelt fish camps, once an important part of the Tolowa economy.

Figure 8: Potential fire pit eroding near CA-DNO-53



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Above: Figure 9: Shell midden lens eroding atTDSP-13-01
Below: Figure 10: Solarized glass and metal fragment found at TDSP-13-01

Smelt fish camps have been recorded in Humboldt and Del Norte County as sparse to moderate-density shellfish scatter surrounded by few tools (Tushingham et. al. 2013). Shannon Tushingham's Sweetwater report noted a roasting pit eroding from the dune in 2004(Tushingham et. al. 2013). Eight liters were sampled from the 100x50cm deep deposit by UC Davis using Flote-Tech floatation machine to identify faunal remains. AMS dates were obtained from organic material and determined the pit to be 165 +/- 50 radio carbon years before present. Additionally, two sigma date ranges indicated that the site was used in the last prehistoric to post-contact period as well (Tushingham et. al. 2013). This is consistent with theories for TDSP-13-01 because of the post-contact materials found.

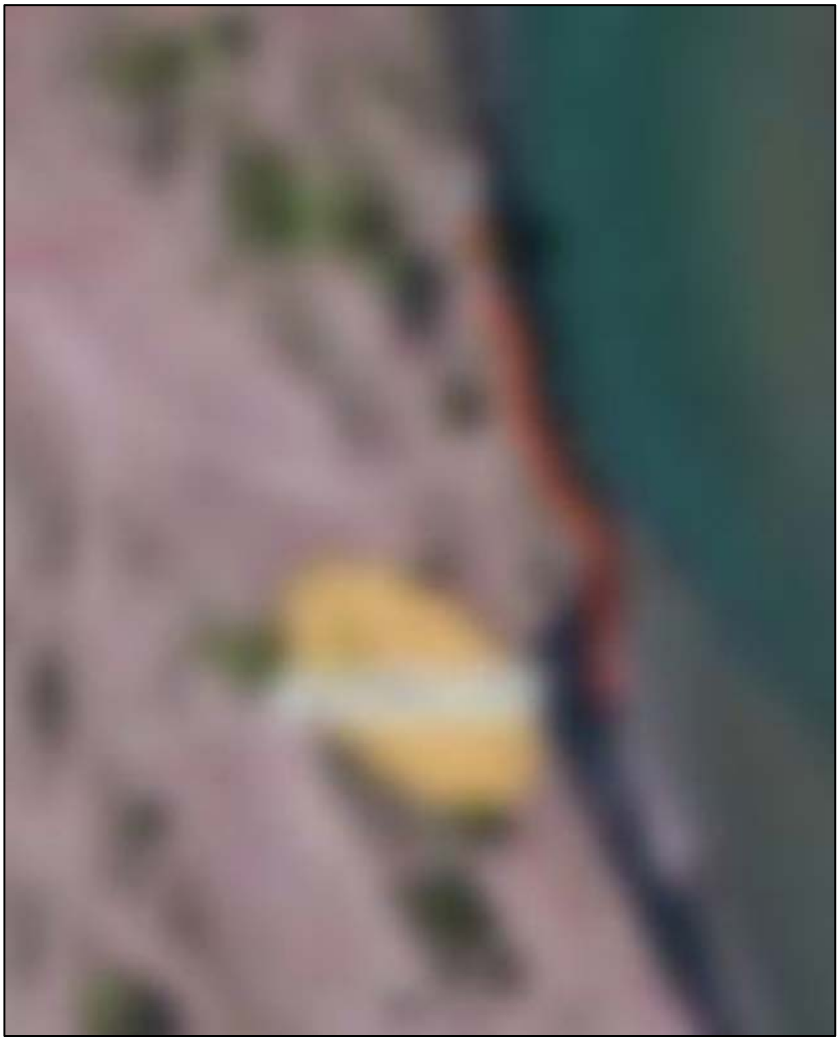
Additional surveys were conducted by State Parks and Smith River Rancheria along the coast totaling 13.2 kilometers (8.25 miles). The northern portion of Tolowa Dunes has a different topography along the beach. Rather than high dune cliffs of the southern portion, the dunes sloped back from the shore, with specks of beach grass growing along them. This indicated that the harsh environmental factors eroding away dunes in the south of Tolowa Dunes were not so abrasive in the north. It is probable that this effect is due to geologic processes and tectonic activity. Though the north was not completely without dune cliffs, there was no noted feature erosion.

SMITH RIVER

Along the Smith River only two sports were surveyed: along the shore below CA-DNO-247 and at a 'big dune' slope just east of where the River Trail ends at the Smith (Figure 12). No artifacts were noted in the area mapped as CA-DNO-247 on the top of the dune. Upon walking the shoreline, a small Gunther point, chert scraper, possible ground stone fragments, shell midden, and charcoal were noted. The Gunther series projection point was another key timeline identifier as a diagnostic artifact (post-2000 B.C. – post AD 500) (Hildebrand 2007). As the shoreline was surveyed, artifacts and survey footprints were quickly submerged by the rising tide. It was determined that the artifacts were actually from a lens 2meters below the top of the dune and had fallen down as they were exposed and surrounding sands disappeared. This could be subsurface artifacts from continuous use at CA-DNO-247, but it is unclear. The lens extended for roughly 72 meters (242 feet) along the shore, and did overlap with the previously known boundary of CA-DN0-247.

The big dune survey included the top, the dune face, and the shoreline during low tide. Only a few charcoal fragments were noted along the shore in a dense clay layer, but it is unclear if it was part of a recent event or had been in the layer much longer. There were no contextual items near it and no indication of habitation was found along the dune face or immediately on top.

Above: Figure 11: Survey along Smith River near CA-DNO-247. *Below:* Figure 14: Area of Big Dune Survey. Smith River Rancheria THPO, Suntayea Steinruck at base of dune,



Left: Figure 12: Survey near known boundary for CA-DNO-247. Red line indicates new site boundary. *Upper Right*: Figure 13: Chert scraper found along river. *Lower Right*: Gunther point found along river.

SURVEY SUMMARY

In total, two large areas of concern and two smaller areas were recorded during the coastal erosion surveys. According to the model maps, a large section of coast is expected to be flooded soon, and we can only expect in the next 20 years to see a 20 cm rise. The question is: What to do now that we know sites are eroding along the southern shore and Smith River? An important factor in decision making will be further understating the underlying geologic processes. A vast difference in landscape and processes is seen along the Tolowa Dunes coast. The Pacific Institute has a model for building protective barricades along the Smith River and associated tributaries, but the idea is more of a theory ("Impacts of Sea-Level Rise on the California Coast: GIS Data Downloads"). The expected cost and time to expected effectiveness does not seem plausible. Excavation of the areas exposed has been briefly discussed, but the first priority in that undertaking is to understand where we will see significant impacts and what we information we might be able to glean from any excavation.

CHAPTER 5: Summary and Conclusion

Sea level rise will drastically affect the Tolowa Dunes coastline, causing significant damage to much of the Tolowa territory. The available predicted models do not incorporate the melting of artic ice sheets. Another major earthquake, associated tsunami and subsidence, will put sea levels along the North Coast higher than previous predictive models. This has far reaching consequences on ecosystems and habitat availability. Some seasonal ponds have already declined seasonal fills and it is apparent that even the beach grass cannot hold-up against the rising tides crashing against them. What little erosion happens every day may not seem as significant now, but over the next few years erosion rates will increase, drastically changing the coastline and taking archaeological sites with it.

This study looks specifically at the coastline and back dunes of Tolowa Dunes State Park. With more research determining accelerated climate change to be a result of anthropogenic stimuli, if Tolowa Dunes were to gain the Natural or Cultural Preserve sub-classifications it could mean the area would need to be protected from climate change effects. Input from The Smith River Rancheria and Elk Valley Rancheria, both federally recognized as Tolowa, has been an important partnership in the past and will become increasingly important as the group discusses the area's past and future.

Although both the National Parks Service and California State Parks both hold policies that allow natural processes (erosion, species migration, etc.) and change to dominate the landscape, there is significant scientific evidence to begin more invasive management plans against impacts from human-induced climatic change (DPR 2011). If extreme repercussions from accelerated climate change are noted—which would be a difficult task to approach—then the same laws apply as if the State were working on an intentional construction project. This could mean migration of ponds, diminished size of area, or seasonal availability will need to be further researched and equipped with mitigation plans. The Yontocket cemeteries are at risk of eroding in the distant future as well.

The flaw in this generalized approach is twofold: how do we determine what is a result of natural climate effects on the region versus what is the result of exponential change from human impact; if climate change is global, how is it determined what effects were created by United State citizens? There currently is no global equivalent to Section 106 to deal with such international situations, but the concern will come to focus on responsibility as a means to focus on who will pay for the protection and mitigation of the region. Tolowa Dunes State Park has the honor of caring for both sacred and environmentally unique locations. As the elements encroach and manipulate the coastline, archaeological information will be swept away, much as it did to the Pleistocene coastline. With the added TEK information from the NPLCC grant, saving data from rising sea-levels will produce a more complete picture of the Yontocket region, which can be used in producing much needed management plans and policies.

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APPENDIX A: MAPS

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